



General

Guideline Title

The acute cardiopulmonary management of patients with cervical spinal cord injuries. In: Guidelines for the management of acute cervical spine and spinal cord injuries.

Bibliographic Source(s)

Ryken TC, Hurlbert RJ, Hadley MN, Aarabi B, Dhall SS, Gelb DE, Rozzelle CJ, Theodore N, Walters BC. The acute cardiopulmonary management of patients with cervical spinal cord injuries. In: Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery. 2013 Mar;72(Suppl 2):84-92. [42 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

Recommendations

Major Recommendations

The rating schemes used for the strength of the evidence (Class I-III) and the levels of recommendations (Level I-III) are defined at the end of the "Major Recommendations" field.

Recommendations

Level III

Management of patients with an acute cervical spinal cord injury (SCI) in an intensive care unit (ICU) or similar monitored setting is recommended.

- Use of cardiac, hemodynamic, and respiratory monitoring devices to detect cardiovascular dysfunction and respiratory insufficiency in patients following acute SCI is recommended.
- Correction of hypotension in SCI (systolic blood pressure <90 mmHg) when possible and as soon as possible is recommended.
- Maintenance of mean arterial blood pressure between 85 and 90 mmHg for the first 7 days following an acute SCI is recommended.

Summary

Patients with acute cervical SCI frequently develop hypotension, hypoxemia, pulmonary dysfunction, and cardiovascular instability, often despite initial stable cardiac and pulmonary function. These complications are not limited to patients with complete SCI. Life threatening cardiovascular instability and respiratory insufficiency may be transient and episodic and may be recurrent in the first 7 to 10 days after injury. Patients with the most severe neurological injuries appear to have the greatest risk of these life-threatening events. Class III medical evidence indicates that ICU

monitoring allows the early detection of hemodynamic instability, cardiac disturbances, pulmonary dysfunction, and hypoxemia. Prompt treatment of these events in patients with acute SCI reduces cardiac- and respiratory-related morbidity and mortality.

Management in an ICU or other monitored setting appears to have an impact on neurological outcome after acute cervical SCI. Retrospective studies consistently report that volume expansion and blood pressure augmentation performed under controlled circumstances in an ICU setting are linked to improved American Spinal Injury Association (ASIA) scores in patients with acute SCI compared with historical controls. Class III medical evidence suggests that the maintenance of mean arterial pressure (MAP) at 85 to 90 mmHg after acute SCI for a duration of 7 days is safe and may improve spinal cord perfusion and ultimately neurological outcome.

Definitions:

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

Class	Therapeutic Studies: Investigating the Results of Treatment	Diagnostic Studies: Investigating a Diagnostic Test	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications
I	High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \ddot{A} , statistic ≥ 0.60 or an intraclass correlation coefficient of ≥ 0.70
	Systematic review ^b of Class I randomized controlled trials (and study results were homogeneous ^c)	Systematic review ^b of Class I studies	
II	Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)	Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \ddot{A} , statistic of 0.40–0.60 or an intraclass correlation coefficient of 0.50–0.70
	Prospective ^d comparative study ^e	Systematic review ^b of Class II studies	
	Systematic review ^b of Class II studies or Class I studies with inconsistent results	Study of nonconsecutive patients; without consistently applied reference "gold" standard	
	Case-control study ^g	Systematic review ^b of Class III studies	
	Retrospective ^f comparative study ^e	Case-control study	
	Systematic review ^b of Class II studies		
III	Case series ^h	Poor reference standard	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \ddot{A} , statistic of <0.40 or an intraclass correlation coefficient of <0.50
	Expert opinion	Expert opinion	

^aA complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

^bA combination of results from 2 or more prior studies.

^cStudies provided consistent results.

^dStudy was started before the first patient enrolled.

^ePatients treated 1 way (e.g., halo vest orthosis) compared with a group of patients treated in another way (e.g., internal fixation) at the same institution.

^fThe study was started after the first patient was enrolled.

^gPatients identified for the study on the basis of their outcome, called "cases" (e.g., failed fusion), are compared with those who did not have outcome, called "controls" (e.g., successful fusion).

^hPatients treated 1 way with no comparison group of patients treated in another way.

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

- Acute cervical spine and spinal cord injuries
- Cardiovascular dysfunction
- Respiratory insufficiency

Guideline Category

Evaluation

Management

Treatment

Clinical Specialty

Cardiology

Critical Care

Neurological Surgery

Neurology

Orthopedic Surgery

Pulmonary Medicine

Intended Users

Advanced Practice Nurses

Hospitals

Nurses

Physician Assistants

Physicians

Respiratory Care Practitioners

Guideline Objective(s)

To update the medical evidence on the diagnosis and treatment of systemic blood pressure support and the role of the intensive care setting since the original 2 medical evidence-based guidelines were published in 2002 and to address the following questions:

- Do patients with acute spinal cord injuries (SCIs) benefit from intensive care unit (ICU) cardiac, hemodynamic, and pulmonary monitoring and care?
- Does blood pressure management influence neurological outcome in patients with acute cervical SCI?

Target Population

Patients with acute cervical spinal cord injury (SCI)

Interventions and Practices Considered

1. Management of patients in an intensive care unit (ICU) or similar monitored setting
2. Use of cardiac, hemodynamic, and respiratory monitoring devices
3. Correction of hypotension
4. Maintenance of mean arterial blood pressure between 85 and 90 mmHg for the first 7 days following injury

Major Outcomes Considered

- Rate of respiratory and cardiopulmonary complications
- Ventilatory time
- Length of stay in intensive care unit (ICU)
- Mean arterial pressure
- Morbidity and mortality
- Incidence of bradycardia and life-threatening bradyarrhythmias
- Neurological outcome

Methodology

Methods Used to Collect/Select the Evidence

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Search Criteria

A National Library of Medicine (PubMed) computerized literature search from 2000 to 2011 was undertaken using Medical Subject Headings in combination with "spinal cord injury": medical management, nonoperative management, hypotension, spinal cord blood flow, respiratory insufficiency, pulmonary complications, and intensive care unit. Approximately 3500 citations were acquired. Non-English-language citations were excluded. Titles and abstracts of the remaining publications were reviewed, and relevant articles were selected to develop the guidelines. The authors focused on 4 specific topics concerning human patients with acute spinal cord injury (SCI): management in an intensive care unit (ICU), cardiac instability, hypotension, and respiratory/pulmonary dysfunction. Additional citations were extracted from the reference lists of the remaining papers. Finally, members of the author group were asked to contribute articles known to them on the subject matter that were not found by other search means. Articles describing economics, epidemiology, anesthesia, monitoring techniques, penetrating cord injuries, nursing care, infectious or urologic complications, chronic complications, or remote SCIs were excluded. These efforts resulted in 11 articles, which form the foundation for this updated review. All studies provided Class III medical evidence.

Number of Source Documents

- Eleven articles form the foundation for the updated review.
- Twenty-seven articles were summarized in Evidentiary Table format (refer to the table in the original guideline document).

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

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I	High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic ≥ 0.60 or an intraclass correlation coefficient of ≥ 0.70
	Systematic review ^b of Class I randomized controlled trials (and study results were homogeneous ^c)	Systematic review ^b of Class I studies	
II	Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)	Development of diagnostic criteria on consecutive patients (with universally applied	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic of 0.40–0.60

Class	Therapeutic Studies: Investigating the Results of a comparative study ^e	Diagnostic Studies: Investigating the Diagnostic Test ^b of Class II studies reference "gold" standard)	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications or an intraclass correlation coefficient of 0.50–0.70.
	Systematic review ^b of Class II studies or Class I studies with inconsistent results	Study of nonconsecutive patients; without consistently applied reference "gold" standard	
	Case-control study ^g	Systematic review ^b of Class III studies	
	Retrospective ^f comparative study ^e	Case-control study	
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III	Case series ^h	Poor reference standard	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} statistic of <0.40 or an intraclass correlation coefficient of <0.50
	Expert opinion	Expert opinion	

^aA complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

^bA combination of results from 2 or more prior studies.

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^dStudy was started before the first patient enrolled.

^ePatients treated 1 way (e.g., halo vest orthosis) compared with a group of patients treated in another way (e.g., internal fixation) at the same institution.

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^gPatients identified for the study on the basis of their outcome, called "cases" (e.g., failed fusion), are compared with those who did not have outcome, called "controls" (e.g., successful fusion).

^hPatients treated 1 way with no comparison group of patients treated in another way.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Selected articles were carefully reviewed by the authors. An evidentiary table was created (refer to the table in the original guideline document) that reflected the strengths and weaknesses of each article.

On occasion, the assessed quality of the study design was so contentious and the conclusions so uncertain that the guideline authors assigned a lower medical evidence classification than might have been expected without such a detailed review. In every way, adherence to the Institute of Medicine's criteria for searching, assembling, evaluating, and weighing the available medical evidence and linking it to the strength of the recommendations presented in this document was carried out.

Articles that did not achieve immediate consensus among the author group were discussed extensively until a consensus was reached. Very few

contributions required extensive discussion. Most articles were easily designated as containing Class I, II, or III medical evidence using the criteria set forth by the author group at the initiation of the literature evaluation process (see the "Rating Scheme for the Strength of the Evidence" field).

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The current author group was selected for its expertise in spinal surgery (both neurosurgical and orthopedic), neurotrauma, clinical epidemiology, and, in several cases, prior experience with guideline development. The topics chosen for inclusion in this iteration of these guidelines are contemporary and pertinent to the assessment, evaluation, care, and treatment of patients with acute cervical spine and/or spinal cord injuries.

Rating Scheme for the Strength of the Recommendations

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field). All supporting studies provided Class III medical evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Several clinical series of human patients with acute spinal cord injury (SCI) managed in an aggressive fashion with attention to blood pressure, oxygenation, and hemodynamic performance report no deleterious effects of therapy and suggest improved neurological outcome.

Potential Harms

Not stated

Qualifying Statements

Qualifying Statements

- Medical evidence-based guidelines are not meant to be restrictive or to limit a clinician's practice. They chronicle multiple successful treatment options (for example) and stratify the more successful and the less successful strategies based on scientific merit. They are not absolute, "must be followed" rules. This process may identify the most valid and reliable imaging strategy for a given injury, for example, but because of regional or institutional resources, or patient co-morbidity, that particular imaging strategy may not be possible for a patient with that injury. Alternative acceptable imaging options may be more practical or applicable in this hypothetical circumstance.
- Guidelines documents are not tools to be used by external agencies to measure or control the care provided by clinicians. They are not medical-legal instruments or a "set of certainties" that must be followed in the assessment or treatment of the individual pathology in the individual patients we treat. While a powerful and comprehensive resource tool, guidelines and the recommendations contained therein do not necessarily represent "the answer" for the medical and surgical dilemmas faced with many patients.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Mobile Device Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

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Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2013 Mar

Guideline Developer(s)

American Association of Neurological Surgeons - Medical Specialty Society

Congress of Neurological Surgeons - Professional Association

Source(s) of Funding

Congress of Neurological Surgeons

Guideline Committee

Guidelines Author Group of the Joint Section of Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons

Composition of Group That Authored the Guideline

Authors: Timothy C. Ryken, MD, MS, Iowa Spine & Brain Institute, University of Iowa, Waterloo/Iowa City, Iowa; R. John Hurlbert, MD, PhD, FRCSC, Department of Clinical Neurosciences, University of Calgary Spine Program, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada; Mark N. Hadley, MD (*Lead Author*), Division of Neurological Surgery, University of Alabama at Birmingham, Birmingham, Alabama; Bizhan Aarabi, MD, FRCSC, Department of Neurosurgery, University of Maryland, Baltimore, Maryland; Sanjay S. Dhall, MD, Department of Neurosurgery, Emory University, Atlanta, Georgia; Daniel E. Gelb, MD, Department of Orthopaedics, University of Maryland, Baltimore, Maryland; Curtis J. Rozzelle, MD, Division of Neurological Surgery, Children's Hospital of Alabama, University of Alabama at Birmingham, Birmingham, Alabama; Nicholas Theodore, MD, Division of Neurological Surgery, Barrow Neurological Institute, Phoenix, Arizona; Beverly C. Walters, MD, MSc, FRCSC (*Lead Author*), Division of Neurological Surgery, University of Alabama at Birmingham, Birmingham, Alabama, Department of Neurosciences, Inova Health System, Falls Church, Virginia

Financial Disclosures/Conflicts of Interest

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this guideline.

Guideline Status

This is the current release of the guideline.

Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) and EPUB for eBook devices from the [Neurosurgery Web site](#)

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Availability of Companion Documents

The following are available:

- Foreword. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):1. Electronic copies: Available in Portable Document Format (PDF) from the [Neurosurgery Web site](#) .
- Commentary. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):2-3. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .
- Introduction to the guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):5-16. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .
- Methodology of the guidelines for management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):17-21. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on July 9, 2013. The information was verified by the guideline developer on October 3, 2013.

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